

Nomogram for calculation of left ventricular volumes

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A nomogram has been devised for the rapid derivation of left ventricular volumes from single-plane angiograms obtained in the 30° right anterior oblique projection. The left ventricular volumes are derived from the use of the area-length formula of Dodge. The computed left ventricular volumes may then be adjusted to correspond to the actual volumes by an appropriate conversion chart.

Single-plane cineangiography in the right anterior oblique projection has been proposed as a technically easier method of obtaining the left ventricular volume than biplane angiography (Kasser and Kennedy, 1969; Snow *et al.*, 1969; Kennedy *et al.*, 1970). This paper presents a nomogram for the rapid derivation of the left ventricular volume from the right anterior oblique angiogram using a modified area-length formula of Dodge *et al.* (1960). It is hoped that this nomogram will prove useful in those medical centres where computers and light-pen writers might not be readily available. This nomogram could also serve as an independent means of rapidly performing or rechecking a large number of calculations involving corrected left ventricular volumes.

Principle

(a) CALCULATION OF LEFT VENTRICULAR VOLUME

The principle of the nomogram (Fig. 1) is based on the formula of an ellipsoid: $V' = 4/3 \pi abc$, where

V' = volume in cm^3

a = semi-major axis = one half length from apex to middle of aortic valve = $1/2 L$ cm.

b = semi-minor axis in right anterior oblique view (cm).

c = other semi-minor axis at right angles to b (not seen in right anterior oblique view).

If it is assumed that the left ventricle is shaped like a prolate spheroid (Dodge *et al.*, 1960) then $b = c$ and $V' = 4/3 \pi ab^2 \dots (1)$

The projection of a prolate spheroid in 30° right anterior oblique view is assumed to be an ellipse (area = $A \text{ cm}^2$) (Dodge *et al.*, 1960).

Then $A = \pi ab \dots (2)$

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Substituting for b in (1) from (2) and letting $L = 2a$

$$\text{we get } V' = \frac{0.848A^2}{L} \dots (3)$$

The volume V' from equation 3 is then adjusted for the magnification of the x-ray film by using a linear correction factor $M (\geq 1)$ where 1 cm true length = M cm on x-ray film as viewed or projected. Hence the computed volume V becomes

$$V = \frac{0.848A^2}{LM^3} \dots (4)$$

Equation (4) was used to compute the volume (end-diastolic or end-systolic) depicted in the nomogram in Fig. 1.

This computed volume V can be adjusted to correspond to the actual left ventricular volume (V_{corr}) as determined by models and post-mortem left ventricles of known volumes (Dodge 1971), using the Dodge equation

$$V_{\text{corr}} = 0.81 V + 1.9 \dots (5)$$

The value of V_{corr} corresponding to V can then be read directly from the conversion scale $V - V_{\text{corr}}$ on the extreme right-hand side of the nomogram.

Application

TO FIND LV VOLUME (RIGHT ANTERIOR OBLIQUE VIEW) (Fig. 2)

With the sharp point of a pencil, mark the length on line L and the magnification factor on line M . Join these two points with a straight line to cross the unscaled line G . By joining the point so obtained on line G and the planimetered area on line A a straight line may be extended to meet line V yielding the volume (cm^3).

If a grid is used to obtain the magnification factor where 1 cm^2 actual area corresponds to $M^2 \text{ cm}^2$ x-ray distorted area (i.e. $M^2 = \text{x-ray distorted area/}$

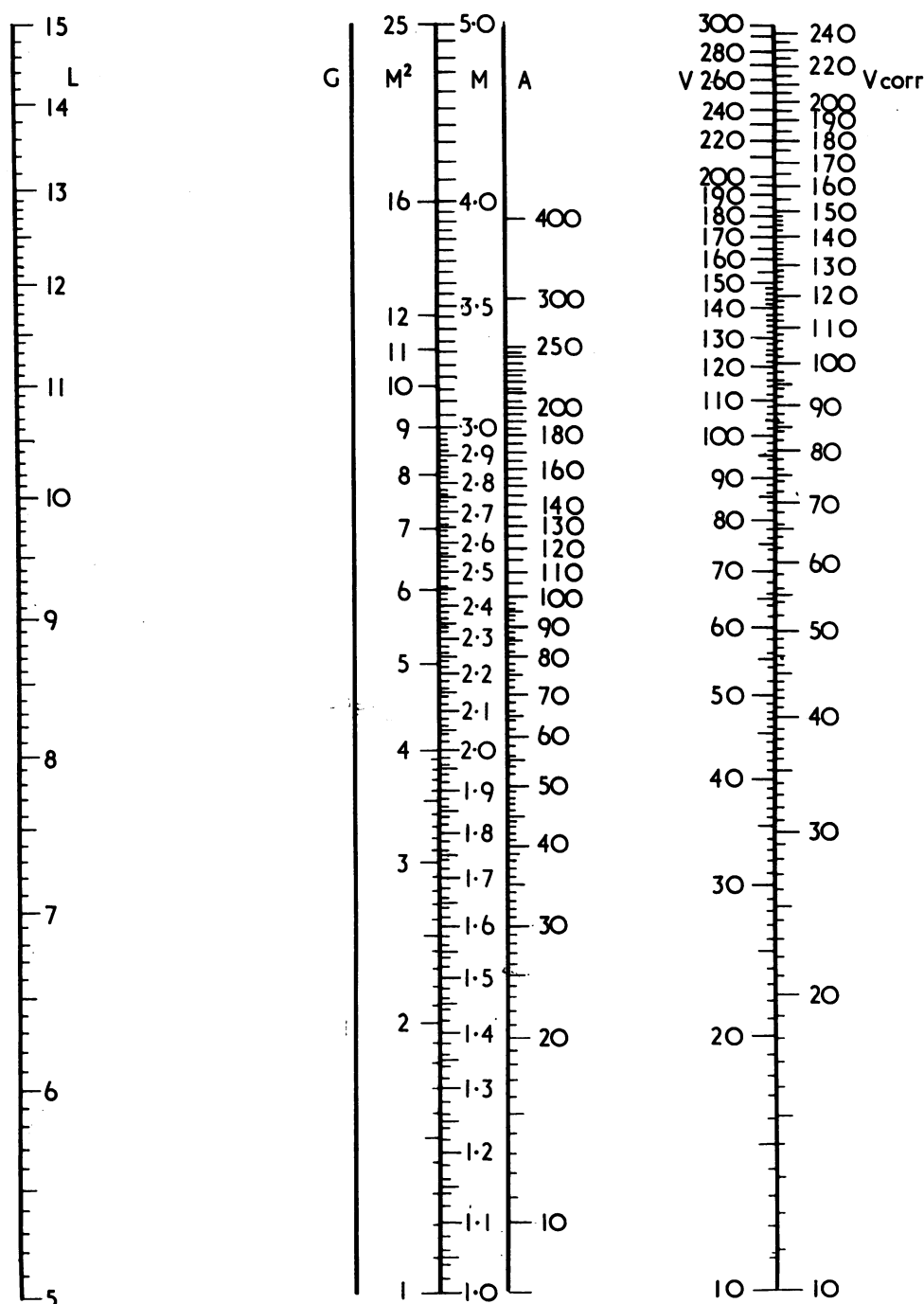


Fig. 1 Nomogram for estimation of left ventricular volume: L =length (cm) as measured from apex to midpoint of aortic valve in 30° RAO view; M =linear magnification factor; M^2 =area magnification factor when a grid is used; A =LV planimetered area in 30° right anterior oblique (cm^2); V =computed volume (cm^3); V_{corr} =corrected volume (cm^3).

A straight line joining L and M (or M^2) intersects the unscaled line G . A second straight line drawn between the point on G and the observed area is extended to V to obtain the computed or corrected volume.

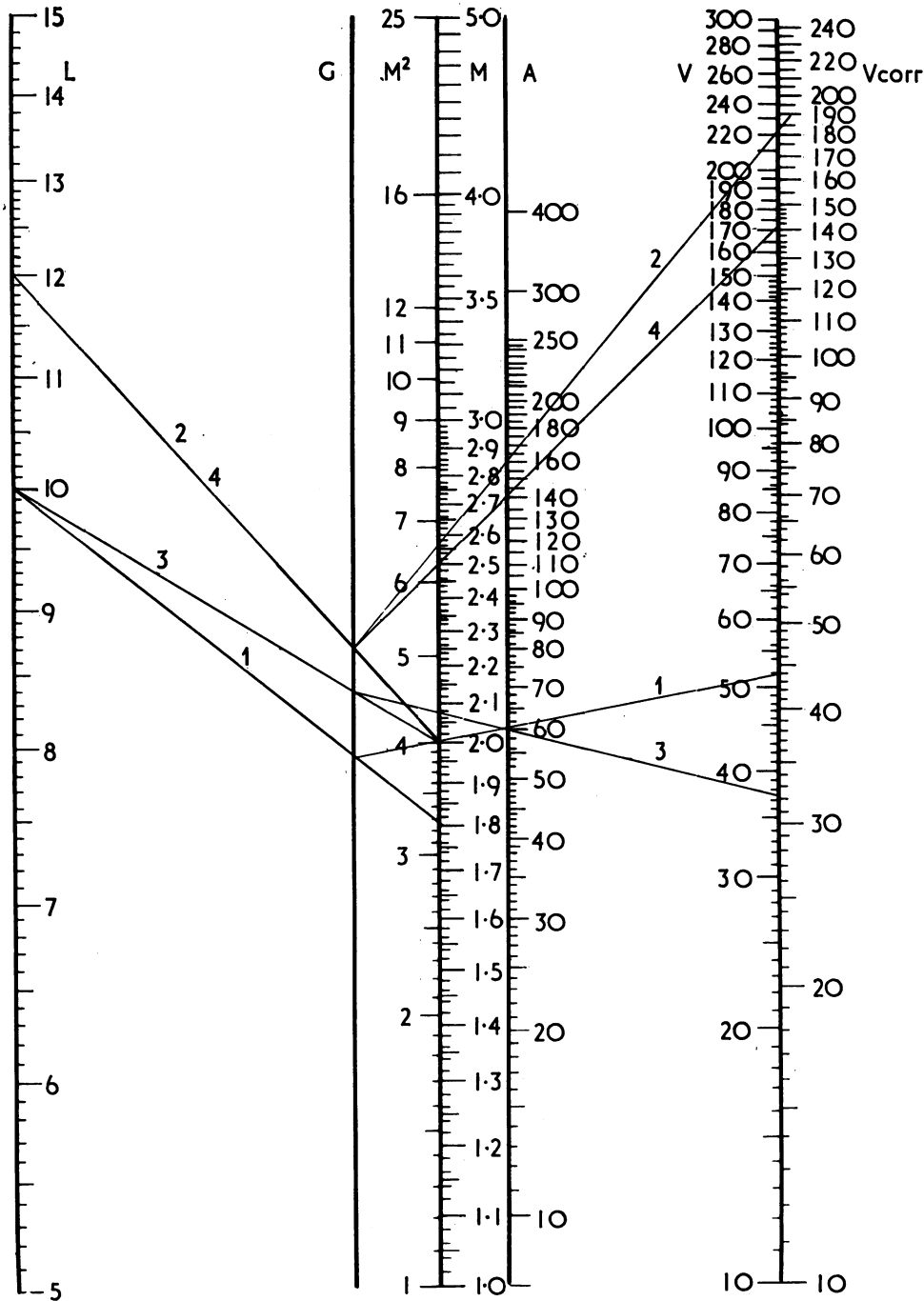


Fig. 2 Illustrated use of nomogram using 4 examples as described in the text (large numbers 1 to 4).

grid area), the value of M^2 on line M^2 is used instead of M on line M (example 2).

If the length is greater than 15 cm, use half of the value of line L and divide the resultant volume by 2 (example 3).

For left ventricular volumes over 300 ml use half of the value of lines L and A and double the resultant volume (example 4).

Examples

- (1) $L=10$ cm, $M=1.8$, $A=60$ cm², $V=52.3$ (by calculation) and 52.5 (by nomogram). $V_{corr}=44.3$.
- (2) $L=12$ cm, $M^2=4$, $A=160$ cm², $V=226$ ml (by calculation) and 225 ml (by nomogram). $V_{corr}=184.2$.
- (3) $L=20$ cm, $M=2$, $A=60$ cm².
 V is found to be 37.5 ml from the nomogram using $L=10$ cm, $M=2$, $A=60$. Hence the computed volume when $L=20$ cm is $37.5/2$ or 18.8 ml. $V_{corr}=17.1$.
- (4) $L=24$ cm, $M=2$, $A=280$ cm².
 V is found to be 172 ml from the nomogram using $L=12$, $A=140$, $M=2$. Hence the volume

when $L=24$, $A=280$, $M=2$, is 172×2 or 344 ml. $V_{corr}=280.5$.

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